Production of Superheavy Elements by the $^{208}Pb(^{86}Kr,1n)^{293}118$ Reaction*

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The usual extrapolations[1] of production cross sections to produce heavy elements (Z=102-112) with ^{208}Pb targets indicate steadily decreasing production rates with increasing Z. According to these predictions, production rates for elements heavier than Z=113 will be too small to be for present experimental techniques. However, Smolanczuk predicts[2] that the fusion of ^{86}Kr with ^{208}Pb should produce ^{293}118 and its decay products with a relatively large cross section, marking a reversal in the production cross section trend.

We searched for the production and decay superheavy elements (SHE) formed in the ^{86}Kr + ^{208}Pb reaction, using the newly completed Berkeley Gas-filled Separator (BGS) at the LBNL 88-Inch Cyclotron. A 300 pnA beam of 459-MeV ^{86}Kr ions bombarded a ~400 μg/cm^2 ^{208}Pb target wheel at the BGS target position. The BGS was set to focus the element 118 evaporation residues to the BGS detector area, and provide a clean separation from unreacted beam and other reaction products.

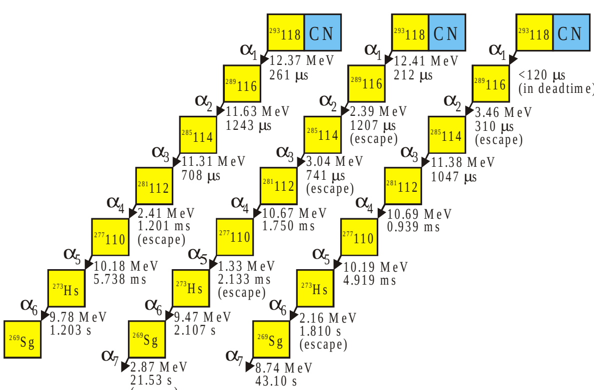

Fig. 1. Observed ^{293}118 decay chains.

At the BGS detector area, recoiling reaction products passed through a parallel plate avalanche detector (PPAC) before becoming implanted in a position-sensitive Si-strip detector. Over a period of 10 days, 3 events which are interpreted as the implantation and decay of SHE were observed (Fig. 1). Each consisted of a heavy element recoil (PPAC + Si-strip) followed by a rapid sequence of position-correlated α-decays (Si-strip only).

The measured α-decay energies for ^{293}118 and the daughter activities can be compared with predictions from various mass models. Such a comparison (Fig. 2) shows that the predictions of Smolanczuk[3] are well reproduced.

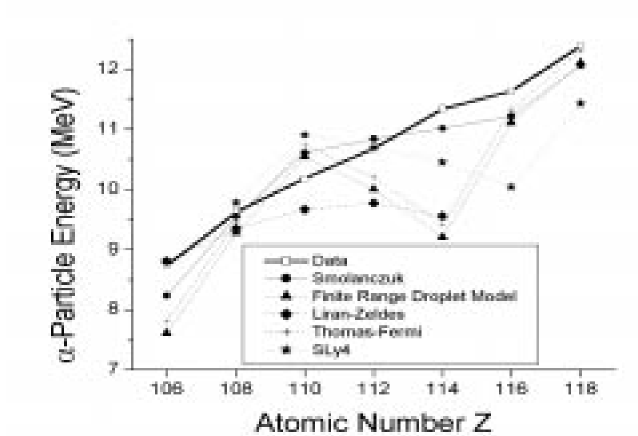

Fig. 2. Comparison of experimental α-decay energies with predictions of several mass models.

^{293}118 was produced with a cross section of 2.2 pb. Although 300 times smaller than the prediction of Smolanczuk, it is orders of magnitude larger than extrapolations of the production cross sections for Z=102-112. This reversal in cross section trend has been explained by "unshielded fusion," where when moving to heavier projectiles with Pb targets, the optimum bombarding energy for the 1n exit channel becomes greater than the Coulomb barrier.

Footnotes and References

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2. R. Smolanczuk, Phys. Rev. C **59**, 2634 (1999).
3. R. Smolanczuk, Phys. Rev. C **56**, 812 (1997); **60**, 21 301 (1999).